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NEW ZEALAND.

GEOLOGICAL SURVEY OF NEW ZEALAND:

PRELIMINARY REPORT ON THE TARANAKI OILFIELD.

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Laid on the Table of the House of Representatives by Leave.

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SITUATION AND EXTENT.

The Taranaki Petroleum Field is situated on the West Coast of the North Island, in the neighbourhood of the principal town of the Taranaki Land District—New Plymouth.

How far the petroleum-field extends is not yet known. Its limitations can probably be more or less roughly indicated as a result of the geological operations now in progress in this part of New Zealand, but its boundaries can be defined exactly only by systematic drilling undertaken as a result of that survey. From the known surface-indications it is thought that the oilfield may be found to extend at least as far east as Waitara, and as far south as a line running roughly from four or five miles south of Inglewood, through German Hill, to the coast. Most of this area is included within the survey districts of Waitara and Paritutu, or the area in which a geological survey is now being conducted.

TOPOGRAPHY.

The most striking physical feature in Taranaki is the splendid symmetrical cone of Mount Egmont, the crest of which is perpetually snow-clad. To the west the cone is flanked by a short range of high mammillated hills rising to a height of 4,387 ft., and known as the Pouakai Ranges. To the north and west of these rise to a height of 2,240 ft. the bush-covered hills known as the Patua or Kataki Ranges. North of the ranges the land slopes in general gently to the sea to the northward and westward, and rises towards the eastward perceptibly to near and beyond the Waitara River. The land is rolling or undulating near the sea, but more hilly inland, especially towards the east. The surface forms part of the Wanganui Coastal Plain, more or less shrouded by volcanics, its irregularities being due to dissection by the numerous streams flowing mainly from the cone of Egmont, and draining either directly to the sea or by means of the Waitara.

The coast-line for many miles is flanked by low cliffs, marking the denudation of the plain by the sea. A few miles west of New Plymouth the volcanic hills, both on the mainland and on the islands in the sea—known as the Sugar Loaves—form part of an old dissected volcano, of earlier age than Mount Egmont.

GENERAL GEOLOGY.

As gathered from good surface outcrops in the neighbourhood of the Waitara River and rare exposures elsewhere, and by the records of the numerous boreholes occurring in different parts of the Taranaki Oilfield, we learn that all of the area now being considered is underlain by the same strata —namely, claystones (locally called "papa"), sandstones, fine conglomerates, and marls. These form part of a great series of rocks which extends northwards, southwards, and eastwards, and which, as judged from the section between Waitara and Te Kuiti, consists in descending order of claystones, sandstones, fine conglomerates, marls, limestones, claystones, and sandstones with coal-seams. Pending a more exact classification by the survey now being conducted in the area, this series must merely be classified as Tertiary in age.

The Tertiary rocks lie generally almost flat or dip at very low angles. They are thought to form part of a great monoclinal fold, dipping southerly and westerly from the Mokau country. Minor cross-swells in the form of anticlines and synclines are in evidence in places, and are thought to be of sufficient importance to markedly influence the position of subterranean reservoirs of petroleum. The Tertiary strata, too, have been considerably broken in places by faults—structural breaks which direct the movements of petroleum and allied products from depths beneath the surface.

Overlying the Tertiary rocks is a coating of volcanic material of varying thickness in various parts of the area under review. It consists petrologically mainly of semi-basic volcanic rocks, and occurs as tufas, agglomerates, and lava flows. Much of this material, it is believed, issued from the old dissected lava cone now seen in the Sugar Loaves and either from Mount Egmont or the more ancient vent from which that volcano rose, but probably some of it emanated from fissures in the surface elsewhere.

Near the sea-coast, especially in the neighbourhood of the Sugar Loaves, occur black-sand beds, generally unconsolidated, but in places more or less cemented by iron-oxide. The beds lie in general horizontal, but exhibit false bedding. They show beds composed mainly of black-sand—ilmenite, magnetite, and titanite—interstratified with beds consisting chiefly of lighter material (quartz sand, felspathic sand, &c.). The black-sand beds are lensoid in shape, and are inconstant both in horizontal and vertical extension. Concentration of the heavier and richer material is constantly proceeding as the result of wind-and-wave action. Thus are produced the heaps of black-sand which collective amount to thousands of tons. These will ultimately be of economic value.

BRIEF HISTORY OF THE FIELD.

It will be impossible in the compass of a paper so brief as this report to give a full description of the various vicissitudes through which the petroleum industry in Taranaki has passed. However, it will be necessary to briefly outline its history in order to appreciate what has been accomplished, and to understand the reasons for the choice of locations of existing bores.

Seepages of petroleum were noted by Dr. Dieffenbach as far back as 1839, near the present site of the breakwater. No attempt, however, at boring for the source of this natural product was made until the end of 1865, when exploration in a primitive way was commenced. A number of wells were drilled in the vicinity of the seepages during the course of the three succeeding years, the deepest being 650 ft. Though at times during these early efforts small quantities of petroleum were obtained, the results were considered so discouraging that twenty years elapsed before renewed efforts were made to exploit the oilfield. In 1888, in great part through the instrumentality of the Hon. Oliver Samuel and the late Sir Julius Vogel, a company was organized in London, which continued operations for about two years. A bore was put down at the rear of the breakwater to a depth of 915 ft. (some authorities say 875 ft.), and a small amount of oil was obtained. Then, for some reason, the company stopped operations, despite the fact that Mr. Booth, the driller of the well, declared that the indications were highly favourable. In 1894 a syndicate known as the New Plymouth Petroleum Company was organized by Mr. Samuel, who remained its moving spirit for some years, during which some eight bores were put down. Of these, the first was put down to a depth of 1,100 ft., within 8 ft. of Booth's drill-hole, and small amounts of oil were raised. The second was sunk on Mr. Mace's farm, at the head of the Herekawa Stream. This bore, called No. 3, was sunk to a depth of 1,534 ft. Not much oil was seen, but large quantities of gas were encountered. The third borehole (known as No. 5) was situated on Putt's farm, on the Spotswood Road. It was sunk to a depth of 2,050 ft., but without the discovery of any favourable indications. The fifth one was somewhat farther inland, being located on Mr. H. Okey's farm, on the Franklyn Road. It was found so difficult to penetrate a mass of loose kidney-shaped stones occurring near the surface that a depth of only 302 ft. was drilled. The sixth bore sunk by the syndicate was on Mr. Veale's farm, some 30 chains from the last site. Drilling was continued by the New Plymouth Petroleum Company to a depth of 1,220 ft., and later by the present Taranaki Petroleum Company to a depth of 1,335 ft. The seventh drill-hole (No. 8 of the Samuel syndicate) was located at the upper end of Honeyfield's farm, Moturoa. It was sunk to a depth of 2,052 ft., but without the discovery of any very encouraging prospects. The eighth bore was situated some 80 ft. from the third borehole put down (called No. 4 by the New Plymouth Petroleum Company), and was sunk to 1,055 ft., when the plant was again moved on to the site of the third bore, which was now continued to a depth of 1,976 ft.

Somewhat previously to these later works, Mr. Samuel's syndicate had dissolved, and their rights, plant, &c., were purchased by Mr. Alexander. He conducted the later operations with a smaller number of shareholders, but eventually closed down, and sold his interests to an Adelaide syndicate, which sent Mr. George Fair to New Plymouth to prosecute further boring in 1904. The first borehole put down was known as the Birthday bore, or the New No. 1. This is situated on Mr. W. J. Honeyfield's property at Moturoa. After getting several small flows of oil the Adelaide syndicate failed to obtain further capital, and went into liquidation. Mr. Fair, however, being sanguine that deeper down were more extensive pools of petroleum, managed to interest a syndicate of local gentleman, who formed the Moturoa Petroleum Company, and the bore was continued. The bore was sunk to a depth of about 2,230 ft., when, in May, 1906, a fair quantity of oil was obtained, and the ever-troublesome water said to be satisfactorily shut off. From this comparative success dates the inauguration of the various other companies still, or until recently, operating in the field. The principal of these are the Moa Petroleum Company, Ltd.; the Inglewood Oil Boring and Prospecting Company, Ltd.; the Standard Oil Company of New Zealand, Ltd.; the Taranaki Oil and Freehold Company, Ltd.; the Bonithon Company, Ltd.; and the New Plymouth Petroleum Company, Ltd.; each of which has put down one borehole, mention of which will be made later in this report. At the same time the Moturoa Petroleum Company underwent reorganization, and has continued operations under the name of the Taranaki

Petroleum Company, Ltd. In addition to No. 1, mentioned above, three new boreholes have been drilled, known as No. 2, No. 4, and No. 5 respectively; while another, No. 3, was continued on the site of the old No. 4 of the Samuel syndicate (the third borehole sunk by that company).

DESCRIPTION OF NATURAL PETROLEUM-SEEPAGES AND GAS-EMANATIONS.

Petroleum oozes out along the beach just east of the breakwater at Moturoa, and this was the indication which led to the drilling in the immediate neighbourhood. No very definite spring from which this oil issues can be located, but it is believed that it comes from a crack or break in the underlying rocks 50 ft. or more in length, or from the upturned edge of these strata resting against the hard rocks of the Sugar Loaves. From this source it would easily well up through the loosely consolidated overlying tufa. However, only very small quantities ever reach the surface—merely traces here and there beneath the boulders on the beach.

A scum of petroleum is frequently seen on the surface of the sea near the breakwater, when the bottom is being dredged.

Gas issues somewhat intermittently in two creeks on Laurent's property near the Carrington Road. As both streams are very muddy and flow over boggy ground, it is thought that the bubbles may merely be marsh-gas, due to decomposition processes near the surface, and not emanating from a deeper source.

Higher up the Carrington Road, above the bore of the Standard Oil Company of New Zealand, and on the property of Mr. A. S. Petch, a number of gas-emanations appear on a small creek, a tributary of the Huatoki. Two (about one chain apart) are especially conspicuous. The upper issues on the edge of the stream on the left side, while the other bubbles forth in a small pool of water filling an artificial excavation. When lighted both burn vigorously for a few minutes, with almost a foot of flame of a yellowish colour. When first discovered and somewhat opened out, the upper jet of gas is said to have burned continuously for ten days.

Further ebullitions of gas on a smaller scale appear on the Huatoki above and below the entrance of the small stream above mentioned. Much of the surface soil of this locality is composed of a curious resin-coloured peat (?), but I am not of the opinion that such strong flows of gas could be derived from this source. They are probably of more deep-seated origin.

About three-quarters of a mile lower down the Huatoki Valley, on a tributary entering on the right side, other jets of gas appear like those on Petch's farm, and apparently almost equally strong. Here some advantage has been taken of the gas, a roughly made cone being placed over the vent to concentrate the gas and give a constant flame when necessary for boiling water, &c., by the men working in the neighbouring fields.

Still lower down the Huatoki Valley, about half a mile from the right bank of its tributary known locally as the Huatokiti, and on the property of Mr. Grooby, Franklyn Road, there is a very strong ebullition of gas issuing on the edge of a tiny puddle of water in an artificial excavation in tufa. The jets flow from several small cracks occurring in an area about 18 in. square, giving when lighted a strong flame 18 in. or 2 ft. in length, which burns without cessation unless somewhat violently extinguished.

Near the Manganui Stream, east of Inglewood, there are several gas-emanations. One, near the Norfolk Road, was not seen by the writer, but it is said to be of considerable dimensions. Somewhat farther south, on the property of Joseph Butler, there occurs on the left bank of the Maungamawheti Stream—a tributary of the Manganui—a pronounced outflow of gas, issuing from a crack a few inches long. This jet formerly flowed out on the bank of the stream, but now the main one issues at the inner end of an artificial cut at some 10 ft. from the water's edge, though minor jets appear between this point and the water. The flame which rises when the principal jet is lighted is strong and well defined, burning to a height of about 18 in., with an orange flame, and said formerly to have risen to fully 4 ft. Above these are other ebullitions of gas for about 50 ft. up the stream, and all are fairly strong emanations issuing from consolidated tufa. This gas and that on Grooby's property are probably the most powerful in the district, and it seems remarkable that they are not utilised for household purposes by the neighbouring farmers.

DESCRIPTION OF THE PRINCIPAL EXISTING BORES.

The Taranaki Petroleum Company, which, as seen in a previous paragraph, is operating at Moturoa, has some five bores, numbered from 1 to 5. No. 1 is what is known generally as the Birthday Well. Small but promising quantities of oil were obtained in Nos. 1, 2, and 3. No. 4, the most easterly well, was drilled to a depth of 1,600 ft., but not a trace of oil or gas was found. No. 5 bore was merely started, being sunk to a depth of only 40 ft.

According to the manager, Mr. W. E. Simpson, the depth of No. 1 borehole at the time of the writer's visit (28th October, 1909) stood at 2,345 ft. The bore has yielded small quantities of oil at various times, but at exactly what depths could not be ascertained. When the petroleum-pool was first pierced the oil rose with violent pressure, and was for a short time a gusher, but now it is purely a pumping proposition. The bore is said to be in a very bad state, the case being bent and even parted, and the hole clogged. It is difficult to ascertain exactly what amount of oil has been obtained from the bore altogether, but the quantity obtained by the present company has not been commercially important.

The No. 2 bore, according to the manager, was at a total depth of 2,346 ft. at the time of the writer's visit. Gas is said to have been struck at 1,500 ft., at 2,183 ft., at 2,192 ft., and at 2,205 ft. A stratum containing oil accompanied by large quantities of salt water was pierced at 2,209 ft. in sandstone, and somewhat lower down another flow was encountered. For some time the oil pumped amounted to ten barrels a day, and was running at that rate when the hole was closed down. The daily quantity was, however, very irregular, being sometimes only four barrels, or even less, and some days much

more, depending apparently on the gas-pressure. It is very difficult to estimate the quantity of oil so far obtained from the well. The amount, however, is said to have been about 30,000 gallons.

Great difficulty was experienced in No. 2, as well as in the other bores, in shutting off the water, and with caving mud and sand. Six-inch casing was used in the hole to a depth of 2,114 ft., and 5 in. to a depth of 2,246 ft.

No. 3 well was the only hole from which oil was flowing in any quantity at the time of the writer's visit. When closed down for some hours, the pressure of gas was sufficient to bring to the surface a few barrels of oil mixed with water, which flowed with considerable force through a 2 in. pipe. It will be remembered that this No. 3 well is on the site of the No. 4 well of the Samuel syndicate (the third one sunk by that company), and had by them been put down to a depth of 1,976 ft. The present company have continued the well to a depth of 2,617 ft. (with 6 in. casing to a depth of 2,538 ft., and 5 in. to a depth of 2, 540 ft.). A few barrels of oil were obtained at a depth of 2,200 ft., but the greatest flow came from a stratum between 2,568 ft. and 2,574 ft. It is thought that by pumping this well might be made to yield a flow of at least ten barrels per day. A considerable quantity of oil has been obtained from the well, but unfortunately no estimate of the amount obtained is available.

The Bonithon bore, the deepest drill-hole on the field, was sunk to a depth of 3,004 ft., but without striking either oil or gas, though a strong flow of pure fresh water was encountered.

The Taranaki Oil and Freehold Company's bore stood at 1,389 ft. when visited. The drill-hole is well cased—15½ in. tubing to a depth of 200 ft., 12 in. to a depth of 777 ft., then 9 in. to a depth of 1,287 ft. Traces of oil are said to have been encountered in the hole, but no more.

At the time of inspection the Standard Oil Company of New Zealand bore stood at 2,500 ft., with 8 in. casing to a depth of 2,300 ft. A little oil is said to have been met with at 1,300 ft. and at 2,300 ft. When visited a new casing was being sunk, and had just reached the lower depth at which oil is stated to have been obtained. Thus the writer was able to see a marked impregnation of oil in the comminuted clay brought up by the sand-pump. The plant at this drill-hole is in excellent shape, and well equipped.

The New Plymouth Petroleum Company's borehole is now closed down. A depth of 1,060 ft. was attained. At that depth it was reported that there were good indications of oil and gas, and that the tools came up dripping with oil.

The Moa Petroleum Company's bore at Inglewood, sunk to a depth of 460 ft., is now closed, and certain of the tools formerly employed are in the bottom of the hole. The site was chosen because of the existence of a fairly strong flow of inflammable-gas bubbles issuing in a neighbouring stream. Considerable gas is said to have been encountered in the borehole.

The Inglewood Oil Boring and Prospecting Company's bore was drilled to a depth of 2,500 ft. No oil was encountered, though there is a strong ebullition of gas, which was ignited and burned with a strong flame at the time of inspection. In the hole, 12 in. to 13 in. riveted casing was used to 80 ft., 10 in. to 300 ft., 8 in. to 1,200 ft., and 6 in. to the bottom. The hole is now abandoned and the derrick dismantled, but the machinery and gear still remain, and appear to be in good repair.

Records of several of the bores are unobtainable or very incomplete, as will be seen from a perusal of the appended logs. Owing to the diversity in the nomenclature of the rocks by the various log-chroniclers, we have endeavoured to reduce the names to one standard (those in common practical or scientific use, though not necessarily the local terms), in order to obtain uniformity.

LOGS.

Taranaki Petroleum Company.

No. 3 Bore.

(Note.—All the available notes as to the character of the strata are here recorded.)

241 ft.	First note as to the strata encountered records a " hard streak "—probably a calcareous concretion in " papa clay."
730 ft. – 744 ft. ..	Strata very hard.
1,824 ft.	" Hard streak."
1,890 ft.	Some oil was pumped from the surface of the water.
2,020 ft. – 2,045 ft. ..	Blue clay and sand.
2,045 ft.	" Hard streak."
2,050 ft. – 2,094 ft. ..	Very soft blue clay and sand.
2,094 ft. – 2,126 ft. ..	Blue clay containing a " hard streak."
2,128 ft.	" Small seam of oil."
2,133 ft.	Small quantity of salt water—in clay.
2,137 ft.	Gas occurred.
2,178 ft. – 2,244 ft. ..	Clay with a " hard streak."
2,289 ft.	Gas and oil.
2,298 ft.	Blue clay only is reported.
2,335 ft.	Harder rock.
2,337 ft. – 2,398 ft. ..	" Granular limestone."
2,398 ft. – 2,411 ft. ..	Coarse sandstone.
2,570 ft. – 2,574 ft. ..	" Gas very strong."
2,600 ft. (about) ..	Very soft sandstone.

No. 4 Bore.

(NOTE.—All available notes as to character of strata are here recorded.)

46 ft.	" Hard sandstone," probably a tuff.
61 ft.	Loose boulder, probably volcanic.
67 ft. 6 in. – 73 ft. 2 in.	"Basalt," probably a solid flow rock of andesitic character.
73 ft. 2 in. – 95 ft.	Loose boulders, probably volcanic.
95 ft. – 98 ft.	Apparently another solid flow rock.
197 ft. – 744 ft.	Sandy claystone (" papa "), with calcareous concretions (" hard streaks ") at 542 ft. and 652 ft.
744 ft. – 798 ft.	" Sand drift."
798 ft. – 1,139 ft.	Sandy claystone (" papa ").
1,139 ft. – 1,539 ft.	Claystone (" sticky papa ").
1,539 ft. – 1,678 ft.	Sand with a good deal of water.

STANDARD OIL COMPANY OF NEW ZEALAND.

Bore.

Surface – 10 ft.	Red volcanic soil.
10 ft. – 28 ft.	Agglomerate (" conglomerate ").
28 ft. – 34 ft.	Hard-caked black-sand.
34 ft. – 52 ft.	Coarse sand and boulders.
52 ft. – 58 ft.	Sand.
58 ft. – 66 ft.	Scoria and gravel.
66 ft. – 98 ft.	Sand, gravel, and silt.
98 ft. – 100 ft.	Boulders and clay.
100 ft. – 165 ft.	Sand, silt, boulders, and scoria.
165 ft. – 176 ft.	Sand.
176 ft. – 420 ft.	Gravel, sand, and boulders.
420 ft. – 487 ft.	Gritty sandstone with concretions (" hard streaks ").
487 ft. – 1,205 ft.	Claystone with occasional concretions (" hard streaks ") in places.
1,205 ft. – 1,250 ft.	Sand and gravel.
1,250 ft. – 1,563 ft.	Sandy claystone varying a good deal in the amount of sand. Shows a trace of oil at 1,325 ft., and contains shells at 1,469 ft.
1,563 ft. – 1,610 ft.	Soft sandstone.
1,610 ft. – 1,640 ft.	Claystone.
1,640 ft. – 1,660 ft.	Soft sandstone with gravel and shells.
1,660 ft. – 1,677 ft.	Claystone with " hard streaks."
1,677 ft. – 1,689 ft.	Soft sandstone with a few boulders.
1,689 ft. – 1,840 ft.	Claystone with gravel and shells.
1,840 ft. – 2,313 ft.	Claystone more or less sandy.
2,313 ft. – 2,376 ft.	Oil and gas in a fine sand.
2,376 ft. – 2,494 ft.	Fine sand with " hard streaks."
2,494 ft. – 2,501 ft.	Clay, gravel, and shells.
2,501 ft. – 2,510 ft.	Fine sand.

INGLEWOOD OIL BORING AND PROSPECTING COMPANY.

Bore.

Surface – 10 ft.	Tufa.
10 ft. – 69 ft.	Soft clay and decomposed agglomerate (apparently).
69 ft. – 250 ft.	Hard sandstone—some escape of gas at times.
250 ft. – 292 ft.	Claystone.
292 ft. – 300 ft.	" Strata of volcanic origin." Increase in gas.
300 ft. – 318 ft.	Fine sandstone.
318 ft. – 355 ft.	Agglomerate (" conglomerate ").
355 ft. – 390 ft.	Same volcanic formation.
390 ft. – 395 ft.	Fine grey sandstone.
396 ft. – 470 ft.	Agglomerate (" conglomerate ") and sand, varying in hardness in different parts.
470 ft. – 750 ft.	Claystone (papa).
750 ft. – 800 ft.	Sandstone containing much water.
800 ft. – 1,278 ft.	Claystone with occasional traces of gas.
1,278 ft. – 1,600 ft.	Sandy claystone.
1,600 ft. – 1,640 ft.	Heaving sand.
1,640 ft. – 2,425 ft.	Claystone with a few traces of gas, and getting harder lower.
2,425 ft. – 2,460 ft.	Claystone—caving.

BONITHON BORE.

Surface – 216 ft.	Clay and agglomerate, getting hard below 64 ft.
216 ft. – 315 ft.	Very sticky papa, sandy claystone (" papa ").
315 ft. – 320 ft.	Hard sandstone.
320 ft. – 740 ft.	Sandy claystone (" papa "), sand, and gravel.

BONITHON BORE—*continued.*

740 ft. – 1,508 ft.	Sandy claystone, with " hard streaks."
1,508 ft. – 1,774 ft.	Sand and gravel.
1,774 ft. – 1,950 ft.	Claystone, with flow of water.
1,950 ft. – 2,086 ft.	Very sticky (" papa ") claystone, with slight flow of gas.
2,086 ft. – 2,091 ft.	Grey sandstone.
2,091 ft. – 2,411 ft.	Claystone.
2,411 ft. – 2,422 ft.	Soft sandstone.
2,422 ft. – 2,520 ft.	Claystone.
2,520 ft. – 2,521 ft.	Hard sandstone.
2,521 ft. – 2,600 ft.	Claystone.
2,600 ft. – 2,610 ft.	Sandstone.
2,610 ft. – 2,683 ft.	Claystone.
2,683 ft. – 2,748 ft.	Soft sandstone.
2,748 ft. – 2,763 ft.	Gas (60 lb. to square inch).
2,763 ft. – 3,004 ft.	Sandstone.

TARANAKI OIL AND FREEHOLD COMPANY.

Surface – 6 in.	Surface mould.
6 in. – 55 ft. 3 in.	Tufaceous clay.
55 ft. 3 in. – 198 ft. 3 in.	Agglomerate showing varying degrees of coarseness.
88 ft.	A layer of carbonised wood.
112 ft.	Slight show of oil.
198 ft. 3 in. – 218 ft	" Very hard rock," possibly a lava flow.
218 ft. – 239 ft.	Clay.
239 ft. – 255 ft.	Agglomerate—base of volcanic rocks.
255 ft. – 588 ft.	Sandy claystone, with " hard streaks " (concretions) at intervals, and with traces of oil near them at 449 ft., 476 ft., 506 ft., 513 ft., 579 ft., and 588 ft. A band of shell sand at 328 ft., and hard mudstone containing shells at 375 ft.
588 ft. – 603 ft. 6 in.	Sandstone, with show of oil.
604 ft. – 657 ft. 2 in.	" Rock," with good show of oil.
657 ft. 2 in. – 659 ft. 5 in.	Gravel.
659 ft. 5 in. – 667 ft. 5 in.	Papa.
667 ft. 5 in. – 669 ft. 6 in.	Gravel.
669 ft. 6 in. – 740 ft.	Hard papa.
670 ft.	Carbonised plant-remains.
672 ft.	Quartzose gravel containing water.
740 ft. – 860 ft.	Greenish argillaceous sandstone—very good show of oil.
860 ft. – 964 ft. 6 in.	Sandy claystone, becoming less sandy downwards.
964 ft. 6 in. – 980 ft. 3 in.	Sandstone, with traces of oil.
980 ft. 3 in. – 1,095 ft.	Greenish petroliferous sand.
1,095 ft. – 1,105 ft.	Calcareous sandstone.
1,105 ft. – 1,160 ft.	Fine sharp sand.
1,160 ft. – 1,162 ft.	Greenish micaceous calcareous sandstone.
1,162 ft. – 1,201 ft.	Fine sharp sand.
1,201 ft. – 1,208 ft.	Hard sandstone.
1,208 ft. – 1,240 ft.	Very fine " dead " sand.
1,240 ft. – 1,256 ft.	Harder rock—probably calcareous concretions.
1,256 ft. – 1,262 ft.	Lignite (but probably not a solid bed).
1,262 ft. – 1,284 ft.	Fine sharp sand, with three thin streaks of carbonaceous matter.
1,284 ft. – 1,289 ft.	Lignite, with thin streaks of coal.
1,289 ft. – 1,385 ft.	Fine sand, with very hard boulders (concretions).

NEW PLYMOUTH PETROLEUM COMPANY, LTD.

Surface – 40 ft.	Clay.
40 ft. – 70 ft.	Decomposed agglomerate.
70 ft. – 185 ft.	Boulders and agglomerate.
185 ft. – 190 ft.	" Very hard blue rock "—probably a lava flow.
190 ft. – 260 ft.	Boulders and agglomerate.
260 ft. – 270 ft.	Loose sand and gravel.
270 ft. – 340 ft.	" Hard blue rock."
340 ft. – 375 ft.	Large boulders.
375 ft. – 510 ft.	Hard sandstone, showing soil.
510 ft. – 515 ft.	Light-blue papa.
515 ft. – 525 ft.	Conglomerate and big hard boulders.
525 ft. – 593 ft.	Sandy claystone (" papa ") and boulders, showing oil.
593 ft. – 618 ft.	Hard boulders, showing oil.
618 ft. – 637 ft.	Hard sandstone, showing gas and oil.
637 ft. – 640 ft.	Big boulders, showing oil and gas.
640 ft. – 651 ft.	Sandy claystone and big boulders, showing oil and gas.

NEW PLYMOUTH PETROLEUM COMPANY, LTD.—*continued.*

651 ft. – 681 ft.	.. Heaving sand, which rises 75 ft. to 90 ft.
681 ft. – 700 ft.	.. Soft caving shale.
700 ft. – 815 ft.	.. Sticky blue mudstone, showing gas and oil.
815 ft. – 862 ft.	.. Fine heaving sand, showing gas and trace of oil.
862 ft. – 944 ft.	.. Hard sandstone, showing oil.
944 ft. – 1,000 ft.	.. Boulders and fine sand.
1,000 ft. – 1,060 ft.	.. Shale and sandstone, showing indications of oil.

QUALITY OF THE OIL AND GAS.

So far as known, the gas from the various jets around New Plymouth has not yet been analysed. It is apparently methane (CH_4), but on this point analyses will have to be made before certainty can be reached.

In 1906 a sample, said to have been obtained from the No. 1 borehole of the Taranaki Petroleum Company, was forwarded to the writer by the late Mr. George Fair. This sample contained—

	Per Cent.
Petroleum spirit below 150° C.	15·0
Water	1·4
Kerosene distilling between 150° and 300° C.	42·0
Lubricating-oil	20·3
Paraffin	13·3
Coke	5·0
Loss	3·0
	100·0

About the same time analyses were made by Professor Thomas H. Easterfield of oil from the same well. The results of his tests, and remarks thereon, are given below :—

	Per Cent.
Benzine distilling between 55° and 150° C.	20
Burning-oil distilling between 150° and 300° C.	40
Heavy oil for lubricating, 300° and 440° C.	37
Pitch	2
Loss	1
Total	100

" *Benzine.*—The crude benzine has a specific gravity of ·764, was colourless, and had a pleasant odour. When redistilled it yielded 66 per cent. of naphtha boiling between 58° and 120° C."

" *Burning-oil.*—The crude burning-oil had a slightly yellow colour. When redistilled it yielded water-white kerosene with only a faint bloom. The oil distilling between 150° and 270° had a specific gravity of ·82. Treatment of this fraction with sulphuric acid and alkali scarcely affected the density of the oil, but removed practically the whole of the bloom. The lead-oxide test indicated the absence of sulphur-compounds. The kerosene is of greater density than ' White Rose Oil,' and shows a greater tendency to smoke when burnt in American lamps. This defect is also shown by Russian kerosenes, but is largely overcome by the practical manufacturer."

" *Heavy Oil and Paraffin.*—The heavy oil sets at the ordinary temperature owing to the deposition of solid paraffin. The maximum amount of paraffin scale which I obtained was equal to 13 per cent. of the crude petroleum. After pressing and remelting, the scale showed a melting-point of 130° Fahr. The yield of paraffin-wax in a properly arranged distillery, fitted for cold filtration, would be greater than in a laboratory experiment. The melting-point of wax would also be raised by systematic sweating as carried out by the modern manufacturer."

" *Lubricating-oil.*—The heavy oil filtered from the wax yielded by the usual acid and alkali treatment a reddish-brown oil of good appearance. The oil is a good lubricant : it was tested upon the crank-shaft bearings and in the high-pressure cylinder of a stationary engine, and gave complete satisfaction."

The oil of boreholes Nos. 1, 2, and 3 may be described as a heavy oil, setting at ordinary temperatures to the consistency of vaseline (or even harder—depending on the temperature) owing to the large amount of contained paraffin. It is brownish in colour, with an occasional faint-green iridescence.

The oil obtained in the well of the Standard Oil Company of New Zealand has, so far as known, not yet been analysed. It is apparently not so heavy an oil as that at Moturoa, and is lighter in colour.

CONCLUSIONS AS TO THE FUTURE OF THE TARANAKI OILFIELD.

Up to the present, success can hardly be said to have been attained in the Taranaki Oilfield, and the question arises, what are the chances for the future ? So many attempts have been made to obtain a payable well at Moturoa that one would naturally feel discouraged for the future were it not that in the writer's opinion a fairly definite reason can be given for the failures. Away from Moturoa drilling can scarcely be said to have yet been prosecuted sufficiently to properly test the field.

There can be no doubt that there are abundant surface indications. Petroleum-seepages have been actually seen by the writer only at Moturoa, though they have been reported from th Waitara River and elsewhere. Natural gas, as mentioned in a preceding paragraph, is widespread. Wherever this occurs in quantity there is a strong probability that it has ascended vertically from porous strata

below, which very likely—but not certainly—contain the other product of distillation of carbonaceous material—namely, petroleum.

As mineral waters nearly always accompany petroleum, mineral springs and the evidence of former mineral springs are to a limited extent favourable indications. Travertine, a deposit of a former mineral spring, occurs at several places in the area, notably at German Hill.

A loose porous stratum, such as a sandstone, a conglomerate, or a limestone, is ordinarily considered the most favourable situation for the occurrence of a large reservoir of petroleum, when this is capped by an impervious stratum such as a shale or a claystone. Interstratified claystones and sandstones have been pierced by the various drill-holes so far sunk; but it may be said that the sandstones, being generally fine-grained and argillaceous, are usually not sufficiently porous to contain much oil. It is thought that most of the small pools so far encountered are either in fissures in both sandstones and claystones, or are very minor impregnations in the more porous of the sandstone beds, and that the oil has arisen through fault-planes (which are widespread in this locality) from reservoirs more deep-seated than those so far pierced by the various bores.

A complete examination of the Tertiary strata so well exposed eastward and northward from Moturoa to the Mokau gives the observer a very fair idea of what may be expected in the drill-holes. Overlying the extensive Mokau coal-beds, the south-westerly extension of which, by coming in contact with volcanic heat or mere increase of heat towards the earth's interior, have been the source of the petroleum, are thick beds of porous green sandstones. It is thought that until these are cut by drilling no very extensive pool of oil will be struck, unless perchance a large fissure rising from great depths is reached above. Consequently it follows that, in the writer's opinion, the drill-holes so far put down at Moturoa are not sufficiently deep, and he would suggest that one hole be chosen, preferably No. 3 (as being the most westerly and consequently apparently the nearest to the source of oil), and pushed down until the porous stratum seen on the Mokau is encountered. It would be quite hypothetical in the present state of the geological survey of the oilfield to say at what depth this stratum will be reached, but it is hoped to obtain more definite knowledge on this point before our work in the locality is complete. Meanwhile the exploratory bore should be proceeding.

In the present state of our knowledge it seems to the writer that hopeful petroliferous country, in which boring might later be carried out with success, lies between the present No. 3 bore and the foot of the breakwater. Any bores, however, sunk in this locality should await the results of the deep trial bore—the continuation of No. 3—and when put down should be located at a sufficient distance from the foreshore to be uninfluenced by the sea.

Away from Moturoa all indications must be closely examined and carefully studied before sites for boreholes are chosen. Ordinarily the crest or near the crest of a faulted anticlinal fold is considered the most hopeful site for boring. To such a natural apex the oil would readily ascend through the faults till a porous stratum was reached, from which stratum further migration upward was prevented by an impervious roof.

It is thought that the geological survey will be able to reveal, especially towards the east of the field, these anticlinal crests, near which gas now issuing—evidently through fissures—suggests petroleum-pools beneath. However, the work has not yet advanced sufficiently to speak definitely on this point. In the eastern part of the area drilling would probably not necessarily have to be prosecuted to such depths as near Moturoa, since there is a general rise of the strata towards the eastward and northward.

It may be remarked in closing that, even with the greatest attention given to all geological details before selecting a borehole-site, there is danger that the lower part of the petroliferous strata encountered " may contain water instead of gas and oil; or may be calcified or silicified instead of being bitumenized; or that water has entered the outcrop of the strata at higher altitudes [than the borehole-site] and ascended through the formation, floating the oil to the surface and carrying the same to the other dip of the anticline "* than that on which the drill-hole is proceeding.

It is unfortunately true that theory and observations cannot be perfect, but they are immeasurably better than the mere guessing which alone can be said to have accounted for the choice of the sites of many of the Taranaki boreholes.

In the writer's opinion the chances for oil in Taranaki may in general be said to be as good as in any imperfectly tried field, and it is hoped that after the observations of the Survey are complete the industry will be pushed as vigorously as surface indications certainly seem to warrant.

6th December, 1909.

* See " The Genesis of Petroleum and Asphaltum in California," by A. S. Cooper. Bulletin No. 16, Calif. State Mining Bureau.

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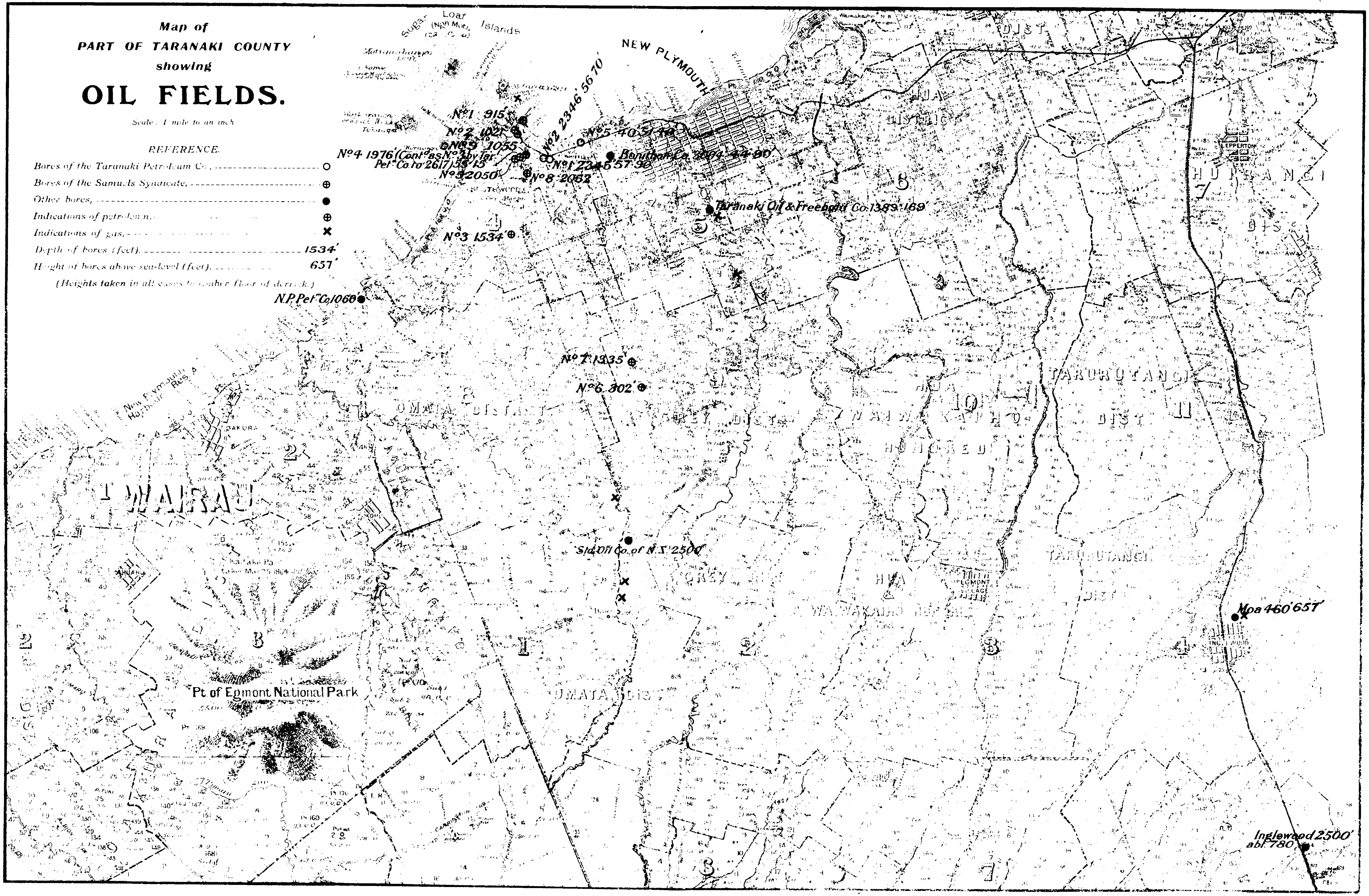
Map of
PART OF TARANAKI COUNTY
showing
OIL FIELDS.
Scale: 1 mile to an inch.
REFERENCE.
Bores of the Taranaki Petroleum Co.
Bores of the Samuels Syndicate,
Other bores,
Indications of petroleum,
Indications of gas,
Depth of bores (feet). 1534'
Height of bores above sea-level (feet). 657'
(Heights taken in all cases to ... floor of derrick.)
NEW PLYMOUTH
No 1 915'
No 2 1021'
No 9 1055'
No 4 1976' (Cont. as No ... by Tar. Pet. Co. to 2617) 55 15
No 3 2050'
No 8 2052'
No 2 2346' 56 70'
No 5 4051' 48
No 1 2346' 57 90
Bonithan Co. 3004' 44 90'
Taranaki Oil & Freehold Co. 1389' 169
No 3 1534'
N.P. Pet. Co. 1060'
No 7 1335'
No 6 302'
Std. Oil Co. of N.Z. 2500'
Moa 460' 657'
Inglewood 2500' abt. 780'
Pt. of Egmont National Park
OMATA DIST.
GREY DIST.
HUA
WAIWAKAIHO HUNDRED
TARURUTANGI DIST.
HURANGI
LEPPERTON
OAKURA
EGMONT VILLAGE
Sugar Loaf Islands
New Plymouth Harbour Res.